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GUIDE FOR USE OF DENTAL MATERIALS

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Indian Standard

GUIDE FOR USE OF DENTAL MATERIALS

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GUIDE FOR USE OF DENTAL MATERIALS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 5 May 1978, after the draft finalized by the Dental Materials Sectional Committee had been approved by the Chemical Division Council.

0.2 A number of Indian Standards have been published on dental materials covering dental amalgams, alloys, cements, plasters, resins, stones, waxes, etc. This guide is being published in order to assist dentists in employing the most suitable methods in the use of dental materials.

0.3 In the preparation of this standard, assistance has been derived from MP 15 : 1967 'Practical guide to the use of dental materials', issued by the Standards Association of New Zealand.

1. SCOPE

1.1 This standard lays down the methods to be employed in the use of dental materials.

2. SILVER AMALGAM RESTORATIONS

2.1 Amalgams

2.1.1 Silver amalgam is an important restorative material. A good amalgam restoration in a properly prepared cavity should last a lifetime.

2.1.2 Design the cavity for adequate support. Inadequately supported areas of amalgam or enamel may fracture under occlusal stress. Since amalgam is weak in tension and edge strength, most amalgam failures are the result of faulty cavity design. Bevels should be short.

2.1.3 A non-zinc alloy is indicated only when it is impossible to maintain a dry field. Delayed expansion is eliminated but the quality of any alloy is still impaired by inclusion of moisture.

2.2 Proportioning

2.2.1 Weigh the alloy and mercury. Since the subsequent properties depend on a properly prepared amalgam, use a balance for correct proportions as recommended by the manufacturer. Never add mercury after the amalgam has been mixed.

2.2.2 Dispensers can be used. A good dispenser used according to directions can give uniform proportioning with the recommended alloy.

2.3 Mortar Mixing

2.3.1 Use a raised-centre mortar. With this type of mortar a uniform mix is produced since the pestle passes over most of the alloy at each revolution.

2.3.2 Remove old amalgam from the mortar with acid. Do not use a mortar with set amalgam in it. A little of 50 percent nitric acid will remove the amalgam. Wash and dry the mortar.

2.3.3 Grind the mortar regularly with carborundum. At least once a week, place a little carborundum and water in the mortar and grind with the pestle until the mortar shows an even matt surface. This is of great importance.

2.3.4 Use a pen grip, not a full hand-grip, on the pestle for mixing. A first grip allows too much pressure on the alloy but a firm pen grip provides a satisfactory pressure.

NOTE — Trituration of amalgam is a mixing, not a grinding, process.

2.3.5 Standardize the mix. With a properly ground mortar and controlled pressure on the pestle, a mix of uniform consistency is easily obtained with a definite number of revolutions or in a certain time.

2.3.6 When the amalgam rises up the side of the mortar, begins to turn over, and first shows a silvery appearance, stop mixing.

2.3.7 Roll the amalgam into a ball to remove from the mortar. Place a piece of paper or rubber dam over the mortar and shake with a rotary motion. The amalgam should collect into a single ball.

2.4 Mechanical Amalgamation

2.4.1 Alloy and mercury can be left together for a limited time. Enough capsules with alloy and mercury can be prepared for, say, 8 hours. This should not be done with tablets.

2.4.2 Use of mechanical mixing is preferred. Amalgamators give more uniform results than hand mixing. They are strongly recommended.

2.4.3 Choose a suitable type. Choose one with a vigorous action, a good timer and, preferably, with a pestle in the capsule.

2.4.4 Use a fine-grain alloy. Controlled fine grain alloys occupy less space in the capsule and produce a smoother mix.

2.4.5 Determine the mixing time of each alloy. Experiment with 1x, 2x, 3x, etc, units and note the times to produce a good consistency. Make sure that the assistant uses these times.

2.4.6 Use a pestle in the capsule. A pestle produces a finer mix in a shorter time.

2.5 Consistency — Do not use dry or 'sloppy' mixes. Just sufficient trituration to give a single soft ball is recommended. Excessive trituration produces contraction and prevents adequate condensation. Under-trituration makes adequate removal of excess mercury difficult.

2.6 Handling

2.6.1 Do not mull. Mulling is unnecessary. However, if practised, the bare hands must not be used. Use a piece of rubber dam or a finger stall.

2.6.2 Express the mercury as the amalgam is used. When the mercury is expressed by squeezing the amalgam, it sets more rapidly. Thus it is advisable to express the mercury from each piece just prior to packing. Use a squeeze cloth or rubber dam.

2.6.3 Moisture must be excluded from the amalgam. Moisture contamination from the hands or during condensation can produce a porous restoration with a poor surface, and delayed expansion can cause sharp pain and projecting margins.

2.7 Condensing

2.7.1 Use multiple mixes for large restorations. With a single mix, setting will have proceeded too far before the completion of a large restoration. Commence the second mix early enough for condensation to be continuous.

2.7.2 Choose a suitable condenser diameter. The plugger must consolidate and not just pass through the amalgam. Diameter must be matched with consistency.

2.7.3 Remove as much mercury as possible from the restoration. The quality of the amalgam increases with a decrease in residual mercury. After packing each layer, use the largest practicable plugger to bring mercury to the surface. Remove the mercury before adding the next increment.

2.7.4 Condense the amalgam with greatest confortable force. Good condensation is essential to successful amalgam restorations. A load of 2·7 to 4·5 kg should be used on a 1·5 or 2-mm plugger. The amalgam

must always be rigidly confined. Use a properly formed and wedged matrix band when necessary. Avoid overhanging margins.

2.7.5 Mechanical condensers can be used. These produce consistently good results with less effort.

2.7.6 Over-pack the restorations. Over-pack and trim back since it is hard to remove the mercury from the top layer.

2.8 Finishing

2.8.1 When carving, do not form deep grooves. The edges are likely to fracture under stress.

2.8.2 Recommend no biting on new amalgam restorations. Biting pressure can easily fracture the amalgam during the first few hours of setting. Recommend time delay according to the type of restoration, but at least one soft meal.

2.8.3 The amalgam should be polished. Polish the amalgam not less than 24 hours after inserting in order to improve tarnish resistance. Avoid heating the amalgam as this produces a mercury-rich surface of poor quality.

3. SILICATE CEMENTS

3.1 Precautions

3.1.1 Keep the bottles closed. Gain or loss of small amounts of moisture in the cement liquid will reduce the quality of the cement. It is most important to keep the bottle closed when not actually in use. The power also needs to be kept free from impurities.

3.1.2 Discard affected and excess liquid. Discard the liquid if cloudiness or crystals appear. Discard the excess liquid when all the corresponding powder is used.

3.1.3 Cool the slab (but not below the dew point). The mixing slab must always be cool and dry. More powder can be incorporated when the ingredients are cool, giving the cement greater strength and lower solubility. (If a mist forms on the slab it is too cool.)

3.1.4 Use an agate or stellite spatula for mixing. Agate is preferable. Abrasion of a steel spatula can change the colour of the cement.

3.1.5 Use the proportions and method recommended by the manufacturer. The manufacturer will recommend the best mix. It is advisable to use it. This is extremely important as thin mixes have very poor physical properties.

3.2 Mixing

3.2.1 Use the dropper properly. To dispense uniform drops, always hold the dropper so that the tip is vertical.

NOTE — To calibrate the dropper use the following method:

Place 2 drops of liquid on the slab. Weigh more powder then required for the 2 drops. Mix in as much powder as necessary for the correct consistency. Weigh the powder left over. The difference will be the weight required. Make a check with the correct weight. Similar calibrations can be made for all numbers of drops required. Each dropper used must be calibrated.

3.2.2 Weigh out the appropriate amount of powder. A balance of 1 g capacity and 5 mg sensitivity is required. Correct weighing will save time and waste, and will produce a better mix.

3.2.3 Use a small area of slab for mixing. Place the powder near the liquid and confine the mixing to a small area. This will limit change in moisture content, give better mixing and less wastage.

3.2.4 Divide the powder into 0·50, 0·25, 0·25 portions; add the large portion first. Using the spatula, divide the powder with the half nearest the liquid. At least half of the powder is added first so that sufficient matrix gel is formed. Follow with each quarter.

3.2.5 Time is important. Use the 60 seconds mix. Timing with a clock, mix the larger portion in 30 seconds and each quarter in 15 seconds. Extra time means less powder added because of the fast setting time.

3.2.6 Standardize the mixing procedure. The following should not vary:

a) Powder-liquid ratio,

b) Rate of adding powder to liquid, and

c) Time of spatulation of each portion.

3.2.7 Cements may be mixed in a mechanical amalgamator. By using a gelation capsule alone or in the amalgam capsule, cements can be mixed satisfactorily in 10 to 15 seconds. Accurate weighing and liquid dispensing is essential.

3.3 Filling

3.3.1 Protect nearby restorations. Use varnish or cocoa butter to protect nearby cements that may dry out especially when exposed outside rubber dam.

3.3.2 Keep the field of operation free from moisture. All moisture must be excluded during insertion. Use of rubber dam is strongly recommended.

3.3.3 Use a suitable cavity liner. Without a cavity liner the silicate cement can cause damage to the pulp.

3.3.4 Contour the strip. Good contouring will prevent the need for final trimming.

3.3.5 Use the correct quantity of cement in the cavity. A single portion is stronger than small additions. The aim should be to make a finished restoration without subsequent trimming.

3.3.6 The matrix must not move during setting. Great care must be exercised to prevent movement of the matrix until it is time to remove it, otherwise fracture of margins may occur. Do not lubricate the strip.

3.4 Finishing

3.4.1 Keep the completed restoration free from contact with moisture until fully set. A protective varnish must be applied when the strip is removed. Contact with moisture during the setting period will ruin the restoration.

3.4.2 Do not remove the surface formed by the strip. The best surface is the one formed by the strip. Use a procedure so that this surface needs a minimum of trimming and no finishing. The glaze once removed cannot be restored.

3.4.3 Use only finest cuttlefish disc at slow speed and with petrolatum for finishing. Finishing produces an inferior restoration but when necessary it must be done at a latter sitting. Coarse abrasives must not be used and production of heat must be minimized.

3.4.4 Once set, the restoration must never be allowed to become dry. Crazing of the surface and shrinkage will occur if it is allowed to become dry at any stage. Silicate restorations in the teeth of mouth breathers can deteriorate rapidly. Protect nearby silicates when making further restorations.

4. USE OF ELASTIC IMPRESSION MATERIALS

4.1 Impression Materials — Read information for pouring models from impressions (*see* **5**).

4.2 Hydrocolloids

4.2.1 *Alginates* — Use the water-powder ratio recommended. For uniform consistency, weigh the powder and measure the water in a measuring cylinder. Too much or too little water weakens the final gel.

4.2.1.1 Regulate the water temperature. Prepare water at the correct temperature for uniform results.

4.2.1.2 Time the mixing of the powder and water. Insufficient mixing reduces the strength of the final gel; overmixing breaks up the setting gel.

4.2.1.3 Spatulate thoroughly without incorporating air. Spatulate vigorously against the sides of the bowl to minimize entrapped air.

4.2.1.4 Use the adhesive supplied or molten sticky wax for adhesion to a plain tray. With the latter, cover the tray with sticky wax. Melt evenly and add the hydrocolloid. This method can be used with metal and acrylic trays.

4.2.1.5 Use perforated trays with care. Plain trays with adhesive are preferable. If the impression pulls out of a hole in the perforated tray it should be retaken.

4.2.1.6 Use a reasonable bulk of hydrocolloid. It is best that the layer of alginate is not too thin.

4.2.1.7 Use the recommended setting time as a minimum. As long a time as is practicable should be allowed in the mouth for setting.

4.2.1.8 Break the seal and remove the impression with a firm, rapid action. Break the seal to reduce the force necessary for removal. Rapid removal reduces the distortion due to undercuts. Care must be taken that the impression does not separate from the tray. Avoid rocking movement. Deformed material may not recover fully.

4.2.1.9 Clean the impression before pouring model. Wash off any blood or mucous that may be on the impression.

4.2.1.10 Surface hardeners may be used. These should not be necessary but those such as 2 percent alum solution may be used. Immerse for 2 minutes and wash thoroughly.

4.2.1.11 Pour the model immediately. This is essential for accuracy, as loss or gain of moisture will distort the impression.

4.2.1.12 Remove the model within 1 hour. It is not advisable to leave the model and impression together for too long a time.

4.2.2 *Agars* — A triple thermostatically-controlled conditioner is a great aid to success. The conditioner should have a unit that will boil water, a storage bath with a temperature range of 63°C to 68°C and a tempering bath held at 39°C to 46°C.

4.2.2.1 Follow the manufacturer's directions. These should be closely followed for best results. Certified products must be accompanied by accurate and adequate instructions.

4.2.2.2 The material should be thoroughly softened. Heat as recommended or for about 10 minutes at or just under the boiling point of water until uniformly liquefied. Each reheating may require a few minutes longer. Sufficient material for a month or so can be prepared if stored properly.

4.2.2.3 After softening, the material should be stored and maintained at a temperature of 63°C to 68°C or as recommended. After the boiling stage store within this temperature range. The material can be used after 10 minutes and up to 2 or 3 months if not allowed to chill.

4.2.2.4 Fill the tray with hydrocolloid from the storage and temper at 39°C to 46°C. For a good consistency approximate times are for 39°C 2 minutes; for 41°C 5 minutes and for 45°C 10 minutes.

4.2.2.5 For direct injection, hold the syringe at storage temperature, 63°C to 68°C. Clear the syringe and inject around the restoration area.

4.2.2.6 Use a rigid tray or ring. The tray or ring must be rigid so that it will not distort during removal.

4.2.2.7 Use a perforated water-cooled tray. This type of tray appears to give best results.

4.2.2.8 Clean the surface of the material in the tray before insertion. Remove the moist surface film either mechanically or with blotting paper before insertion.

4.2.2.9 Cool the impression completely before removal. Cool with circulating water at 20°C to 22°C for 5 minutes.

4.2.2.10 Observe the method set out in **4.2.1.8** to **4.2.1.12** as for alginates.

4.3 Rubber Base and Silicone Materials

4.3.1 Thoroughly mix accelerator and base. Mix until there are no streaks.

4.3.2 Temperature and humidity have a great effect on setting time. The settting time decreases with increase of temperature and humidity. For longer working time use a lower mixing temperature.

4.3.3 Follow the manufacturer's recommendation for altering setting time. The setting time can be controlled by the amount of accelerator used but large variations should not be made.

4.3.4 Use a rigid tray or ring. The tray or ring must be rigid so that it will not deform during removal.

4.3.5 Use an adhesive to retain rubber base material on the tray. Adhesives are better than mechanical retention. Suitable adhesives should be supplied or recommended by the manufacturer. Some industrial contact adhesives are suitable.

4.3.6 Use a perforated tray for silicones. Owing to the lack of adhesion and suitable adhesives a perforated tray should be used.

4.3.7 The material must adhere completely to the tray when the impression is removed from the mouth. Any lifting of the impression material from the tray is likely to produce a distorted impression.

4.3.8 The impression material should be about 2 mm thick. A uniform thin film gives best results.

4.3.9 Ensure that the material is set before removal. When no perceptible indentation is made with a blunt spatula, the material is set out but allow as long as practicable before removal as the properties improve with time.

4.3.10 Break the seal and remove the impression with a firm, quick action. Break the seal to reduce the force necessary for removal. The rapid removal produces less permanent deformation.

4.3.11 Clean the impression thoroughly. Remove any blood or mucous that may be on the impression.

4.3.12 Pour the model immediately or within the recommended time. It is best to pour the model at once.

5. USE OF PLASTER AND STONE

5.1 Precautions

5.1.1 Proper storage of plaster and stone is essential. Insist on buying plaster and stone in moisture-proof containers. Store in a dry place. Replace lids on tins immediately after use. Once a package is opened transfer contents to an airtight drum. Use a daily storage tin raised above the level of mixing height to avoid splashes.

5.1.2 Use the manufacturer's water-powder ratio. All gypsum products should be used at the recommended consistency.

5.1.3 Do not treat plaster with contempt. Because of its widespread use, little care is often exercised with plaster. Uncontrolled 'average' mixes are inferior. Use the correct ratio. Weigh the powder. Use a measuring cylinder for the water.

5.2 Mixing

5.2.1 Judge the strength of a plaster or stone. The less water required for mixing to a given consistency the greater will be the strength.

The consistency and strength of plasters or stones is shown in Table 1.

TABLE 1 CONSISTENCY AND STRENGTH OF PLASTER OR STONE

Sl No.	Material	Water/Powder Ratio	Strength at 1 Hour
(1)	(2)	(3)	(4)
			kg/mm²
i)	Plasters	0·55 : 0·40	0·7 to 1·4
ii)	Stones	0·40 : 0·30	2·1 to 2·8
iii)	Die stones	0·30 : 0·20	Over 3·5

5.2.2 A thin stone can be weaker than a thick plaster. Again the strength is determined by the water/plaster ratio.

5.2.3 Do not use excessively thick mixes. The strength and hardness reach a peak around the manufacturer's ratio. There is no advantage in stiffer mixes.

5.2.4 Spatulate so that a minimum of air is incorporated. Be careful not to produce porosity by incorporation of air. Adding powder to water in a rubber bowl by sifting reduces porosity.

5.2.5 Remove air from the mix. Vibrate air from the mix and vibrate while pouring.

5.2.6 Vacuum increases the strength, reduces the number of bubbles but can leave a few large bubbles. Together with vibration it should produce a better mix.

5.2.7 Mechanical spatulation is an advantage. Mechanical spatulation slightly increases the strength of the mix and forms uniform but very fine voids. This method produces the most consistent and uniform results.

5.3 What to Use

5.3.1 Use extra strong stones for models. Special model stones with high strength and a hard surface are available for model or cast.

5.3.2 Stone should be used for flasking dentures. Stone is indicated for flasking dentures particularly around the teeth in order to withstand processing pressures and to minimize tooth movement.

5.3.3 Stone and plaster can be mixed. Mixtures of plaster and stone can be used for intermediate strength. The strength will follow the proportion of each if the water-powder ratio is adjusted to give a definite consistency. The setting time is usually between the original times.

5.4 How to Use

5.4.1 Thoroughly wash the impression before pouring model; remove excess water. The impression should be clean and free from excess water but not dry.

5.4.2 Flow stone progressively into impressions with moderate vibration. The stone must be flowed progressively so that air bubbles are not trapped. Once formed they are difficult to displace.

5.4.3 Be careful not to distort the impression during pouring of the model. It is safest to fill the impression and add the base when the stone has set. Gross distortion can occur if the impression is invested and pressed into a heap of stone.

5.4.4 Give attention to the information on the handling of impression materials given in **4** during pouring of the model.

5.4.5 The formation of powdery surface from impressions should be prevented. This may be due to the impression material or the stone or to the particular combination as some combinations are incompatible. If surface hardeners do not produce an improvement, one of the materials may have to be changed.

5.4.6 Limit the quantity of hot water used for wax elimination. Gypsum is slightly soluble, especially around 40°C but less so near boiling point. Prolonged treatment with water will erode the surface.

5.4.7 Sometimes it is desired to increase surface hardness of a model. Borax solution hardens the surface of plaster but not of stone. Generally recommended agents are usually ineffective as hardners but may function as lubricants.

6. USE OF DENTURE BASE ACRYLIC RESINS

6.1 The Mould

6.1.1 The use of plaster and stone is dealt with in **5**. This will help in preparing a satisfactory mould.

6.1.2 Use plaster and stone appropriately when flasking. Stone should be used wherever possible for processing acrylic resins but provision must be made for removal of the denture without damage.

6.1.3 *Choice of Separating Agent*

6.1.3.1 *Ptaster to plaster* — Petrolatum or alginate base separators can be used. Alginate separating agents cause a slight surface whitening to most acrylic resins and a greater tendency to crazing. Because of their ease of application this fault is not usually considered serious enough to prevent their use. The whitening is removed during the polishing operation.

6.1.3.2 *Plaster to acrylic resin* — Only tin-foil will give ideal results and should always be used for clear palates.

6.2 Mixing

6.2.1 Use the manufacturer's ratio. This is usually 3·5 to 1. This can be achieved by first dispensing the required volume or liquid from a graduated cylinder or pipette. While tapping the jar, add powder until a dry surface is formed. Pour off any excess. Stir thoroughly to blend pigments. Do not add more powder when the surface becomes 'wet' again.

6.2.2 Keep the mixing jar closed. After the initial stirring to blend pigments keep the jar closed to prevent evaporation of monomer.

6.2.3 Do not use thin mixes to delay doughing time. Thin mixes result in excessive shrinkage and can produce porosity or voids. This is bad practice. Buy a slow doughing resin or cool the dough.

6.2.4 Do not prepare dough above 55°C. Doughing may be speeded by heating but high temperatures may start polymerization producing an unsatisfactory mix. The elevated temperature will reduce the time that the dough remains suitable for packing and may prevent satisfactory trial closure.

6.3 Packing

6.3.1 Clean the embedded teeth. Ensure that there is nothing on the teeth that will prevent union with the denture base. Do not leave it to change.

6.3.2 Handle the dough with care. Bare fingers can easily discolour the dough. Handle with wet cellophane.

6.3.3 Pack dough at the right stage.

6.3.3.1 *Manufacturer's instructions* — Follow the manufacturer's instructions.

6.3.3.2 *Heat process* — When the dough separates cleanly from the bottle.

6.3.3.3 *Cold process* — Usually packed a little earlier, possibly without trial packing.

6.3.4 Packing time of dough depends on room temperature. Longer working time is obtained with lower temperatures. A dough may be prepared and stored in a refrigerator for later use if monomer evaporation is prevented by wrapping in a plastic film.

6.3.5 Do not use excessive pressure when trial packing. Excessive pressures can be easily exercised on the resin and the teeth during trial packing of the acrylic resin. Follow the closure slowly with moderate pressure until firm contact is made. Then close with firm pressure.

6.3.6 Do not close flask on soft resin at final closure. If the resin is not reasonably firm before the final closure, there will not be sufficient pressure on it during the processing cycle. Make sure of metal-to-metal contact on final closure to prevent ' open bite '.

6.4 Processing

6.4.1 Use the correct processing cycle. Process resins at 65°C to 70°C for 8 hours or longer, preferably overnight, or at 65°C to 70°C for $1\frac{1}{2}$ hours, followed by boiling for half an hour. It is absolutely essential for thick sections that the temperature is not raised above 70°C before $1\frac{1}{2}$ hours.

6.4.2 Regarding the choice of the high or low temperature process the least dimensional change appears to be obtained by the long time-low temperature process. It is claimed that the fatigue strength is also greater.

6.4.3 Cool the flask slowly after processing. Slow cooling is very important. If possible, turn off the heat and cool in the bath; otherwise, bench cool for 30 minutes and immerse in tap water for 15 minutes before opening.

6.4.4 Cold-processed resins for dentures have about three-quarters of the transverse strength of and greater flexibility than heat-processed resins. Porosity and shrinkage defects are difficult to avoid. When used, closely follow manufacturer's directions.

6.5 Repairs

6.5.1 Use cold-processing resins or low-temperature processing. Warping and shrinkage is less likely with low temperature.

6.5.2 *Cold-Processing Resins versus Hot-Processing Resins* — When used to repair heat-processed dentures, strength of the former is about two-thirds of, and flexibility the same as the latter.

6.5.3 Use cold-processing resins according to manufacturer's directions. The method is often quite different from normal. Some give better results when used thin and without pressure. Use as directed.

6.5.4 Do not use sharp edges for repairs. Smoothen the fractured edges to prevent stress concentration in repairs. No sharp edges or locks are required.

6.5.5 Use 1 : 4 polymer/monomer solution for painting repair surfaces. This mixture is used to soften old material instead of monomer which may spread and cause crazing near the repair.

6.6 Finishing

6.6.1 Use wet grinding and polishing to prevent overheating. Use a wet mop with both pumice and a suitable polishing agent. Overheating during polishing can cause warpage of the denture.

6.6.2 Store the denture in water. The denture should always be moist, particularly for the try-in as the dimensions change with absorption of water.

7. PREPARATION OF WAX PATTERNS FOR CASTING

7.1 Softening

7.1.1 Heat the inlay wax uniformly and slowly. Variations in temperature within the wax impression will cause distortion of the pattern. It is preferable to use a wax annealing oven at 50°C prior to heating over the flame.

7.1.2 Do not pass the wax through the flame. Hold the wax above the visible flame for uniform heating. Never allow it to 'run'.

7.2 Pattern Preparation

7.2.1 Keep steady pressure on the impression until the wax is firm. Pressure on the pattern will take up contraction until the wax hardens, thus filling the cavity at or near mouth temperature when the wax becomes rigid. Two minutes could easily be required.

7.2.2 Limit subsequent melting and additions. These cause areas of residual stress which lead to distortion.

7.2.3 Do not chill for removal of the pattern. A good quality wax will be firm at oral temperature. Chilling can distort the surface and margins. Slow cooling is the best procedure.

7.2.4 Smoothen the surface of the pattern with a piece of fine silk. Polish the wax pattern before removal, with a piece of fine silk, rubbing towards the margins.

7.2.5 Use special waxes for indirect inlay techniques. The certification of inlay waxes provides for a special wax for indirect inlay techniques, since they are not used at oral temperature.

7.3 Spruing

7.3.1 Good spruing is essential. Sprues must be designed in number, size and placement for smooth passage of the gold and to take up shrinkage during solidification.

7.3.2 Use a hollow sprue former for simple castings. A tabular sprue former gives better adhesion to the pattern and will produce less wax distortion since it holds less heat. Overheating of sprue may cause 'suck back' of wax.

7.3.3 Use the correct sprue diameter. Use 0·254 to 3·175 mm sprue range for small to large castings.

7.3.4 Use the correct length of sprue and ring for inlays. Use a sprue of about 7·5 mm effective length. The thickness of investment above the top of the pattern should be 6 to 9 mm. For large and intricate patterns, vents to within this distance may be required.

7.3.5 Use a reservoir with thin sprues. With sprues finer than the section of attachment add a reservoir within 1·8 mm to prevent shrinkage porosity.

7.3.6 Use a thick connection between reservoir and pattern. Gold may solidify at too fine a connection between the reservoir and pattern before the casting is complete.

7.3.7 Attach the sprue former at the thickest section. Gold may solidify while passing through restricted areas and prevent filling of the mould.

7.3.8 Multiple wax sprues are necessary for large patterns. Each section of larger area separated by fine sections should be sprued.

7.3.9 Use a crucible former of correct depth and shape. The shape must allow smooth access of the gold into the mould.

7.4 Precautions

7.4.1 Wax patterns contact. Note the contraction data supplied with the wax. The dimensional change depends on the difference between the temperatures of the wax when the pattern is taken and when it is invested. This may vary from summer to winter.

7.4.2 Wax is easily distorted. Patterns must be kept away from heat and direct sunlight. Never hold in the fingers.

7.4.3 Invest the wax pattern immediately. Make this the regular practice. If this is not possible, store in a refrigerator but allow to come to room temperature before investing.

7.5 Auxiliary Materials

7.5.1 *Investing and Casting* — For successful investing and gold casting, refer to **8**.

7.5.2 *Further Information for Indirect Inlay Techniques* — Refer to **4** relating to the use of elastic impression materials, for impression taking, and to **5** relating to the use of plaster and stone for model making.

8. INVESTING AND GOLD CASTING

8.1 Investing and Casting

8.1.1 Use a cristobalite investment for direct inlays. A cristobalite investment should be used as it has adequate and uniform thermal compensation over a wide casting range.

8.1.2 Follow **7** for the preparation of direct wax patterns for casting.

8.1.3 There is only one method to achieve regular success. That is by rigidly following in every small detail a good technique with proper equipment.

8.2 Investing the Pattern

8.2.1 Prepare the pattern as indicated in **8.1.2**. Investing follows on from the part recommended.

8.2.2 Clean the pattern and paint with wetting agent. Clean the pattern carefully and thoroughly. A thin complete film of wetting agent should remain after painting the pattern. Remove any excess with a squeezed-out brush.

8.2.3 Use a thick layer of asbestos. A layer about 0·6 mm thick allows for lateral expansion and still holds the mould in the ring.

8.2.4 Prepare the asbestos liner carefully. Line the ring carefully so that the wet asbestos is not compressed. Allow excess water to drain off.

8.2.5 Use the recommended water-powder ratio. For reproducible results the water must be measured accurately and the powder weighed. Measure the water in a burette. Weigh the powder. Exact proportioning is essential for good results.

8.2.6 Paint the pattern with investment. Flow the investment progressively over the pattern with a camel hair brush so that air bubbles are not trapped. A mild vibration will help this operation.

8.2.7 Fill the ring before the painted pattern dries. The painted pattern must not dry out before investing is completed.

8.2.8 The use of vacuum is indicated. Vacuum used during mixing and particularly prior to or during pouring produces improved surface quality and lessens nodules.

8.2.9 Vacuum with mechanical spatulation and investing gives good uniform results for inlays. Very satisfactory equipment is available for this method. This is strongly recommended for inlays.

8.2.10 Use hygroscopic expansion intelligently. Hygroscopic expansion with some inlay pattern may cause distortion because of varying cross section and restrictions due to the hard wax pattern.

8.3 The Burn-Out

8.3.1 The investment should not be dry for burn-out. The investment must be wet during burn-out because the steam aids the process and prevents molten wax from penetrating the investment. Immerse in water for about 10 minutes if drying out has occurred.

8.3.2 *Burn-Out Procedure* — Allow at least 1 hour after set of investment before commencing burn-out. The safest burn-out is to heat slowly in a furnace from room temperature. Hold at casting temperature for half an hour; or preheat at 200°C to 250°C for up to 1 hour for large moulds, than place in a furnace at 450°C and heat to casting temperature. A ring thoroughly soaked in water can be placed in a furnace at 450°C and slowly raised to casting temperature. To prevent cracking due to uneven heating, keep the rings as far as possible from hot furnace walls. Place the mould in the furnace; sprue down.

8.4 Casting

8.4.1 Heat the ring separately from the gold. A hand swinger is only successful with an expert operator. Heating the gold in the ring prevents use of correct sprue size. A furnace with a temperature controller should be used to heat the ring. A separator casting machine (usually centrifugal) should be used for casting.

8.4.2 Use correct casting temperature and time. The casting temperature of the ring should be at the middle to three-quarters of the casting range recommended by the manufacturer. Hold the ring at the casting temperature for about half an hour. Cristobalite investments are cast at about 600°C, a quartz investment at 600 to 700°C; but note manufacturer's instructions. Excessive heating at high temperature will break down the bona and produce a poor surface on the casting.

8.4.3 Use clean gold for casting. Re-used gold should be thoroughly cleaned before use.

8.4.4 Use the light-blue centre cone of flame for melting gold alloy. This central zone is slightly reducing and should cover the gold (the reducing zone of the flame produces a bright area when held momentarily on a sheet of copper).

8.4.5 Correct use of flux is important. Straight borax boric acid fluxes can change the composition of an alloy by dissolving the oxides. A reducing flux (containing finely divided carbon) with or without borax is preferable. Sprinkle a little flux on the alloy at red heat and again just before casting.

8.4.6 Quench the ring after casting. Allow casting to cool for a minute or two and quench in water for quality and ease of removal.

8.5 Pickling

8.5.1 A bright casting is not necessarily the best. A thin oxide film easily removed by acid is the best casting finish.

8.5.2 Use 50 : 50 acid pickle. Use 50 : 50 sulphuric or hydrochloric acid. For safety pour acid into water.

8.5.3 Heat the acid, not the casting. Place casting in a porcelain pickling dish; pour on acid and boil. Pour off acid into storage vessel (with cover) that will not break with hot acid.

8.5.4 Do not use old green pickle, or metallic instruments to hold casting in acid. Either of these form a copper film that tarnishes easily and is difficult to remove.

8.6 Finishing — Good practice requires very little finishing. A light buffing only is required if all details are meticulously followed.

9. ZINC PHOSPHATE CEMENTS

9.1 Precautions

9.1.1 Keep the bottles closed. Gain or loss of small amounts of moisture in the cement liquid will reduce the quality of the cement. It is important to keep the bottle closed when not actually in use. The powder also needs to be kept free from impurities.

9.1.2 Discard affected and excess liquid. Discard the liquid if cloudiness or crystals appear. Discard excess liquid when corresponding powder is used up.

9.1.3 The slab must be clean, smooth, and dry. A badly scratched slab should be replaced. Any moisture will appreciably affect the setting time and other properties.

9.1.4 Cool the slab (but not below the dew point). The mixing slab must always be cool and dry. (If a mist forms on the slab it is too cool.)

9.1.5 A stainless steel spatula may be used. As the basic material is not very abrasive, a stainless steel spatula is satisfactory.

9.1.6 Use the proportions and method recommended by the manufacturer. For certified products, the manufacturer must give accurate and adequate instructions for proportioning and mixing.

9.2 Mixing

9.2.1 Use the dropper properly. To dispense uniform drops, always hold the dropper so that the tip is vertical.

NOTE — To calibrate a dropper for amount of powder required use the following method:

Place 2 drops of liquid on the slab. Weigh out more powder than is required for the 2 drops. Using the method below, mix in as much powder as required for the desired consistency. Weigh the excess powder and calculate the quantity used for the mix. Make a check mix with the correct weight of powder. Similar calibrations are made and recorded for each consistency required and for each number of drops used. These quantities can be used quickly to give reproducible results.

9.2.2 Weigh out the appropriate amount of powder. A balance of 1 g capacity and 5 mg sensitivity is required for cements. Correct weighing will save time and wastage and give a better mix.

9.2.3 Use a small area of slab for mixing. The smaller area will reduce the amount of moisture added or lost during mixing. The temperature will not rise appreciably.

9.2.4 Divide the powder into portions, the smallest being near the liquid. The manufacturer should indicate how the powder is to be added. For standard testing the powder is divided into four quarters. One-quarter is halved and one of these is halved again to give 1/4, 1/4, 1/4, 1/8, 1/16, 1/16 with the smallest units near the liquid.

9.2.5 Add the small portions first. For zinc phosphate cements, start with the smallest portions.

9.2.6 Time the mixing of each portion.

9.2.6.1 If not stated by the manufacturer, mix the portions in the times given as follows:

Portion	1/16	1/16	1/8	1/4	1/4	1/4
Time (seconds)	10	10	10	15	15	20

9.2.6.2 Total time for mixing should not be longer than $1\frac{1}{2}$ minutes.

9.2.7 Standardize the mixing procedure. Changes in quantity and time will change the setting time.

9.2.8 Use as thick a mix as practicable. The properties improve with thicker consistencies. For orthodontic bands, thin mixes can attack tooth enamel. As cavity liners, thin mixes have greater effect on the health of the pulp. As a cement, thin mixes are weaker and more soluble.

9.2.9 Use as a liner only for shallow cavities. The cement affects the pulp if the cavity is deep. For capping and deep cavities, calcium hydroxide or similar material should first be used.

9.2.10 Ensure strong retention by using a thin film for cementing inlays. The film is limited by the grain size produced during manufacture. The maximum allowable is 0·040 mm. The thinner the film the better the fit and retention.

INDIAN STANDARDS

ON

DENTAL MATERIALS AND ALLIED PRODUCTS

Dental Materials

IS:

6035-1970 Zinc phosphate dental cement
6036-1970 Alginate dental impression material
6037-1970 Zinc oxide-eugenol dental impression paste
6038-1970 Dental impression compound
6039-1970 Zinc oxide-eugenol dental cement
6043-1970 Copper phosphate-zinc phosphate dental cement
6555-1972 Dental laboratory plaster
6556-1972 Dental impression plaster
6884-1973 Dental silicate cement
6887-1973 Denture base polymer
6888-1973 Dental inlay casting wax
7348 (Part III)-1975 Glossary of terms relating to dentistry: Part III Dental materials
7425-1974 Dental casting investment for gold alloys
7966-1976 Dental modalling wax
8019-1976 Dental artificial stone
8020-1976 Baseplate, dental
8021-1975 Dental sticky wax
8022-1976 Acrylic resin teeth
8571-1977 Dental porcelain
8815-1978 Tooth designation for dental purposes (two digit system)
8850-1978 Guide for use of dental materials
8864-1978 Autopolymarizing (acrylic) resins for dental use

Dental Alloys and Amalgams

3571-1966 Dental gold solders
3578-1966 Dental gold alloy wire
3610-1966 Dental gold foil
4704-1968 Silver-tin dental amalgam alloy
4705-1968 Dental mercury
4799-1968 Dental casting gold alloys
5954-1970 Dental white gold alloys
6889-1973 Method for chemical analysis of silver-tin dental amalgam alloy
6890 (Part I)-1973 Method for chemical analysis of dental gold alloys: Part I Determination of gold, silver, copper, palladium and platinum
6890 (Part II)-1975 Method for chemical analysis of dental gold alloys: Part II Determination of nickel and zinc
7225-1974 Dental cobalt chromium casting alloys